

What is claimed is:

1. A method for lining a host conduit that is adapted to contain a fluid, comprising:

- (a) placing a lining member into a host conduit, the lining member comprising an inner layer, an
5 outer layer, and an inflatable enclosure formed between the inner layer and the outer layer;
(b) introducing fluid into the enclosure to inflate the lining member, thereby creating a selected
spacing between the inner layer and the outer layer;
(c) introducing curable material into the selected spacing; and
(d) curing the curable material to form a new liner within the host conduit.

2. The method of claim 1, wherein the inner layer of the lining member defines a bore
located exterior to the enclosure, and further comprising introducing fluid into the bore to
separately inflate the bore, thereby expanding the lining member radially toward the host
conduit.

3. The method of claim 1, wherein steps (b) and (c) are performed simultaneously such that
the fluid introduced into the enclosure to inflate the liner material is the curable material.

4. The method of claim 1, wherein the lining member further comprises spacers in the
enclosure, and wherein the lining member has a unitary construction such that the inner layer,
outer layer, and spacers are formed together as a single component, and wherein the step of
placing the lining member into the host conduit comprises inserting the inner layer, outer layer,
and spacers into the host conduit simultaneously.

5. The method of claim 1, wherein the inner layer is a compression liner and the outer layer
is a preliner, and wherein the step of placing the lining member into the host conduit comprises
separately inserting the compression liner and the preliner into the host conduit.

6. The method of claim 1, wherein the lining member comprises flexible spacers for
defining the selected spacing between the inner layer and the outer layer during curing, and
wherein the flexible spacers are capable of being folded prior to insertion during use.

7. The method of claim 1, wherein the lining member is placed into the host conduit by inverting the lining member.

8. The method of claim 1, wherein the curable material is a resin selected from the group consisting of a polyester resin and a vinyl ester resin, and wherein the step of curing the curable material comprises a step selected from the group consisting of applying ultraviolet light to the resin, applying heat to the resin, and mixing the resin with a catalyst.

9. The method of claim 1, wherein the curable material has a viscosity prior to curing that is less than about 500 centipoise at 77°F.

10. The method of claim 1, wherein the lining member further comprises a spacer within the enclosure that defines the selected spacing between the inner layer and the outer layer, and wherein the new liner has a wall thickness that is substantially equal to the selected spacing.

11. The method of claim 1, further comprising inserting a rib within the enclosure to define the selected spacing between the inner and outer layer so that the new liner has a predetermined wall thickness.

12. The method of claim 1, wherein the step of introducing fluid into the enclosure forms a channel in the lining member, and further comprising inserting a communication device into the channel.

13. The method of claim 1, further comprising inserting a hollow rib into the enclosure of the lining member, the hollow rib being configured to house a communication device during use.

14. The method of claim 1, wherein the lining member further comprises a plurality of seams within the enclosure that define channels within the enclosure.

15. The method of claim 1, wherein the lining member further comprises a plurality of corrugations within the enclosure that define channels within the enclosure.

16. The method of claim 1, further comprising forming a channel in the lining member running in a direction lengthwise down the lining member, and further comprising adding a reinforcing mesh to the channel to strengthen the channel.

17. The method of claim 1, further comprising inserting a reinforcing mesh into the lining member between the inner surface and the outer surface, the reinforcing mesh substantially surrounding the inner surface of the lining member to reinforce the new liner.

18. The method of claim 1, further comprising forming channels in the lining member that inhibit slump when the curable material is introduced into the enclosure.

19. The method of claim 1, wherein the inner layer of the lining member forms a bore that is located exterior to the enclosure, and further comprising forming a hanging channel onto the inner layer that is located exterior to the enclosure and extends into the bore.

20. The method of claim 1, further comprising adding a rib into the enclosure of the lining member to define the selected spacing between the inner layer and the outer layer, the rib being substantially solid and comprising a surface, openings in the surface, and voids that communicate with the openings, and further comprising introducing the curable material through the openings and into the voids to reinforce the lining member.

21. The method of claim 1, wherein the lining member further comprises a plurality of spacers having different sizes so that the lining member forms a new liner that has an increased thickness near a preselected area of the host conduit.

22. The method of claim 1, wherein the lining member further comprises a first row of spacers in the enclosure, and a second row of spacers stacked on top of the first row of spacers.

23. The method of claim 1, wherein the lining member further comprises a first row of seams in the enclosure, and a second row of seams stacked on top of the first row of seams, the first and second rows of seams being staggered from one another.

5 24. The method of claim 1, wherein the lining member further comprises a plurality of channels, at least some of the channels comprising openings that form passages permitting fluid to pass between the channels.

10 25. The method of claim 1, wherein the step of introducing fluid into the enclosure further comprises forming channels in the enclosure by passing the fluid into the channels to inflate the channels, the channels being isolated from another and capable of being separately inflated to different pressures.

15 26. The method of claim 1, wherein the lining member comprises channels having an internal pressure and a size determined by the internal pressure, and wherein the fluid introduced into the enclosure inflates the channels, and further comprising introducing the fluid to pressurize the channels to a selected pressure to alter the size of the channels, thereby altering the selected spacing between the inner layer and the outer layer and controlling a thickness of the new liner.

20 27. The method of claim 1, further comprising inserting spacers into the enclosure to make the selected spacing between the inner layer and the outer layer substantially uniform around the enclosure in the new liner, and further comprising inserting a support member into the host conduit to maintain the spacers at a predetermined spacing relative to one another.

25 28. The method of claim 1, further comprising making an opening in the outer layer of the lining member and passing curable material through the opening to the host conduit to repair a defect or damaged area in the host conduit.

30 29. The method of claim 1, wherein the lining member has a length that is greater than about 250 feet.

30. The method of claim 1, wherein the step of placing the lining member into a host conduit comprises positioning the lining member into a protective covering and moving the protective covering through the host conduit to inhibit the lining member from contacting objects within the host conduit.

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31. The method of claim 1, further comprising inserting a shunt insert into the host conduit adjacent to an offset in the host conduit prior to the step of placing the liner material into the host conduit.

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32. The method of claim 1, wherein the lining member further comprises a lateral intercept liner extending from the outer layer, and further comprising locating a lateral pipe connected to the host conduit and extending the lateral intercept liner from the host conduit into the lateral pipe, and further comprising introducing the curable material into the lateral intercept liner.

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33. The method of claim 1, further comprising passing a tapered smoothing device through the lining member to smooth the new liner as it is being formed in the host conduit.

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34. The method of claim 1, wherein the host conduit is selected from the group consisting of an underground pipe, a pipeline, a pipe for containing hydrocarbons, a pipe for containing saltwater, a pipe for containing industrial chemicals, a water pipe, and a sewer pipe.

35. An apparatus for lining an inner wall of a host conduit that is adapted to contain fluid, comprising:

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an inflatable lining member, the lining member being sufficiently flexible to permit it to be inserted through the host conduit during use and being capable of substantial flattening when it is in an uninflated state, the lining member comprising:

a substantially flexible outer layer;

a substantially flexible inner layer attached to the outer layer, the inner layer being inflatable to define a bore during use;

an inflatable enclosure defined between the inner layer and the outer layer, the enclosure being inflatable separately from the inner layer and adapted to receive and contain curable material during use;

one or more substantially flexible spacers positioned within the inflatable enclosure, the spacers forming one or more channels running in a direction lengthwise along the lining member;

and wherein the lining member is expandable toward the inner wall of the host conduit during inflation of the inner layer, the lining member being further adapted to receive and contain the curable material within the enclosure while the curable material is being cured to form a new liner within the host conduit.

36. The apparatus of claim 35, wherein the spacers define a selected spacing between the inner layer and the outer layer during curing, and wherein the spacers are capable of being folded prior to insertion of the lining member into the host conduit.

37. The apparatus of claim 35, wherein the lining member is insertable into the host conduit by inversion.

38. The apparatus of claim 35, further comprising curable material located within the channels, the curable material having a viscosity that is less than about 500 centipoise at 77° F.

39. The apparatus of claim 35, further comprising curable material located within the channels that is curable upon exposure to ultraviolet light, and wherein the lining member is substantially transparent to facilitate curing.

40. The apparatus of claim 35, wherein the spacers are seams within the enclosure that define the channels within the enclosure.

41. The apparatus of claim 35, wherein the spacers are corrugations within the enclosure that define the channels within the enclosure.

42. The apparatus of claim 35, further comprising a reinforcing mesh located around at least a portion of one of the channels to strengthen the channel.

43. The apparatus of claim 35, further comprising a reinforcing mesh located between the inner layer and the outer layer, the reinforcing mesh substantially surrounding the inner layer to reinforce the new liner.

44. The apparatus of claim 35, further comprising a hanging channel located on the inner layer that extends into the bore.

45. The apparatus of claim 35, further comprising a rib extending at least partially through one of the channels to form a surface that is more soft or more rigid than other channels after curing has taken place.

46. The apparatus of claim 35, wherein the enclosure comprises a width that is defined by the spacers, and wherein the spacers are substantially the same size so that the width of the enclosure is substantially uniform around a circumference of the lining member to permit the new liner to have a substantially uniform thickness.

47. The apparatus of claim 35, wherein the enclosure comprises a width that is defined by the spacers, and wherein at least one of the spacers has a different size than the others to vary the width of the enclosure around a circumference of the lining member to permit the new liner to have more thickness near a selected area of the inner wall of the host conduit.

48. The apparatus of claim 35, wherein at least one of the spacers is a substantially solid rib comprising a surface with a plurality of openings on the surface, the rib further comprising voids communicating with the openings that are adapted to contain curable material during use to reinforce the rib.

49. The apparatus of claim 35, further comprising a communication device positioned within one of the channels.

50. The apparatus of claim 35, wherein the spacers are arranged in at least two rows including a first row and a second row that is stacked on top of the first row.

5 51. The apparatus of claim 35, wherein the spacers comprise seams that are arranged in at least two rows including a first row and a second row that is stacked on top of the first row, and wherein the first and second rows of seams are substantially staggered from one another.

10 52. The apparatus of claim 35, wherein the spacers are configured to inhibit passage of curable material between adjacent channels to inhibit slump during use.

53. The apparatus of claim 35, wherein the channels comprise openings that form passages permitting fluid to pass between the channels.

15 54. The apparatus of claim 35, wherein the channels are separately inflatable and have a size that is determined by how much pressure is contained in each channel, the size of the channels being adapted to substantially increase or decrease in response to a change in the pressure.

20 55. The apparatus of claim 35, further comprising a support member between the spacers to maintain the spacers at a selected spacing relative to one another.

56. The apparatus of claim 35, wherein the outer layer of the lining member comprises an opening in a preselected area for passing curable material through the opening to the host conduit to repair a defect or damaged area in the host conduit.

25 57. The apparatus of claim 35, wherein the lining member has a unitary construction such that the inner layer, outer layer, and the spacers are formed together as a single component.

30 58. The apparatus of claim 35, wherein the lining member has a length that is greater than about 250 feet.

59. The apparatus of claim 35, wherein the enclosure has a width that is substantially equal to a wall thickness of the new liner.

60. The apparatus of claim 35, further comprising a protective covering for containing the lining member while the lining member is installed into the host conduit, the protective covering being adapted to deposit the lining member along the host conduit while inhibiting the lining member from moving against objects located on the inner wall of the host conduit.

61. The apparatus of claim 35, further comprising a lateral intercept liner extending laterally from the lining member and capable of being inserted into a lateral pipe that branches off from the host conduit.

62. The apparatus of claim 35, further comprising a tapered smoothing device that is sized to pass through the lining member and smooth the new liner as it is being formed in the host conduit.

63. A method for lining a host conduit that is adapted to contain a fluid, comprising:
(a) placing a liner material into a host conduit, the liner material forming a plurality of channels located between at least a portion of the liner material and the host conduit, the channels being separately inflatable;
(b) introducing curable material into at least some of the channels to inflate them, thereby creating a selected annular spacing between the liner material and the host conduit; and
(c) curing the curable material to fix the liner material in place within the host conduit.

64. The method of claim 63, further comprising leaving at least one of the channels substantially free of curable material, and further comprising placing a fiber optic cable into the channel free of curable material.

65. A method for lining a host conduit that is adapted to contain a fluid, comprising:
(a) placing a substantially flexible liner material into a host conduit, the liner material comprising a lumen and a plurality of channels running in a direction lengthwise down the host conduit, the channels being formed between spacers that prevent liquid from passing between the channels;
5 (b) introducing fluid into the lumen of the liner material to expand the liner material in a radially outward direction toward the host conduit;
(c) introducing curable material into at least some of the plurality of channels to form filled channels, the curable material being introduced separately into the channels; and
(d) curing the curable material to fix the liner material in position within the host conduit.

10 66. The method of claim 65, wherein the step of introducing curable material further comprises leaving at least one of the plurality of channels substantially free of curable material to form a communication channel, and further comprising inserting a communications device into the communication channel.

15 67. A method for lining a conduit that is adapted to contain a fluid, comprising:
(a) placing a first liner material into a host conduit, the first liner material being substantially flexible and comprising a lumen;
(b) placing a second liner material into the host conduit within the lumen of the first liner
20 material, the second liner material being substantially inflatable and comprising an inner surface and an outer surface;
(c) locating a spacer between the first liner material and the outer surface of the second liner material to maintain an annular spacing therebetween;
(d) placing a curable material within the annular spacing;
25 (e) introducing a fluid within the second liner material to exert a force against the inner surface of the second liner material to inflate the second liner material toward the host conduit;
(f) curing the curable material to fix the first and second liner material into position within the host conduit; and
(g) forming a communication channel on the inner surface of the second liner material, the
30 communication channel being adapted to house a communication device.

68. The method of claim 67, further comprising inserting a fiber optic cable into the communication channel.

69. The method of claim 67, wherein the first and second liner material are formed into a unitary lining member prior to being placed into the host conduit, and wherein the spacer is a seam running between the first liner material and the second liner material.

70. A method for lining a host conduit that is adapted to contain a fluid, comprising:

(a) placing a liner material into a host conduit, the host conduit comprising an inner wall, the liner material comprising an inner surface and an outer surface, the inner surface defining a lumen, the outer surface comprising a plurality of protruding spacers running in a lengthwise direction down the liner material;

(b) introducing fluid into the lumen to expand the liner material toward the inner wall of the host conduit, thereby forming a plurality of substantially continuous channels running in a lengthwise direction down the host conduit, the channels being formed between the protruding spacers;

(c) introducing curable material into at least some of the channels; and

(d) curing the curable material within the channels to form a new liner within the host conduit.

71. The method of claim 70, wherein the channels are defined by the spacers and the inner wall of the host conduit.

72. The method of claim 70, further comprising leaving at least one of the channels substantially free of curable material to form a communication channel, and further comprising inserting a fiber optic cable within the communication channel.

73. A method for lining a conduit that is adapted to contain a fluid, comprising:

(a) placing a liner material into a host conduit, the host conduit having a circumference;

(b) locating a plurality of spacers between at least a portion of the liner material and the host conduit at various locations around the circumference of the host conduit to create a first selected spacing between the liner material and the host conduit that is defined by the plurality of spacers;

(c) locating an additional spacer between the liner material and the host conduit, the additional spacer having a width that is different from that of at least one of the plurality of spacers, thereby creating a second selected spacing between the liner material and the host conduit, the second selected spacing being different than the first selected spacing;

5 (d) placing a curable material within the host conduit; and

(e) curing the curable material to fix the liner material within the host conduit to form a new liner within the host conduit that has a non-uniform wall thickness such that the new liner is thicker near a selected area of the host conduit.

10 74. A method for lining a host conduit that is adapted to contain a fluid, comprising:

(a) forming a liner having a substantially cylindrical shape and a width, the liner being substantially flexible and comprising a surface with a slit running axially along the surface that facilitates compression of the liner;

15 (b) exerting a compressive force on the liner to compress the liner and thereby reduce the width of the liner;

(c) inserting the liner within the host conduit while maintaining the compressive force on the liner; and

(d) removing at least some of the compressive force on the liner to cause the liner to expand in a radial direction, thereby fixing the liner in place within the host conduit.

20 75. The method of claim 74, further comprising inserting at least a portion of the liner into a sled bag to exert the compressive force on the liner.

25 76. The method of claim 74, wherein the liner is a shunt insert that is positioned adjacent to an offset in the host conduit.

77. A method for lining a host conduit having an inner wall, comprising:

(a) placing a liner material at least partially within a protective covering to substantially inhibit the liner material from moving into objects protruding from the host conduit, the protective

30 covering comprising a front end and a back end;

(b) positioning the liner material into the host conduit by moving the protective covering through the host conduit while simultaneously releasing the liner material from the back end of the protective covering to reduce or eliminate movement of the liner material directly across the inner wall of the host conduit;

- 5 (c) removing the protective covering from the host conduit;
(d) inserting curable material into the host conduit adjacent to the liner material; and
(e) curing the curable material to form a new liner within the host conduit.

78. The method of claim 77, further comprising placing a substance on the front end of the
10 protective covering to reduce friction between the inner wall and the protective covering during movement of the protective covering through the host conduit.

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